REMARKS

Claims 8, 15 and 23-35 are all the claims presently pending in the application. Claims 8, 15, 23, 25 and 29 have been amended to more particularly define the invention. Claims 31-35 have been added to claim additional features of the invention. Attached hereto is a marked-up version of the changes made to the specification and claims by the current Amendment.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability.

Claims 15 and 23 stand rejected under 35 U.S.C. § 102 as being anticipated by Zheng (US Patent No. 5,728,621). Claims 8, 24-27 and 29-30 stand rejected under 35 U.S.C. § 103 as being unpatentable over Zheng (US Patent No. 5,728,621) in view of Liao (US Patent No. 6,110,795). Claim 28 stands rejected under 35 U.S.C. § 103 as being unpatentable over Zheng in view of Brewer (US Patent No. 6,322,600).

These rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a semiconductor substrate which includes at least one trench comprising seamless filler material having an upper surface which is unpolished and co-planar with a upper surface of said substrate.

Conventional substrates having shallow trench isolation (STI) regions require harsh reactive ion etching (RIE) or chemical mechanical polishing (CMP) to planarize the surface of the substrate and filler material formed in trenches in the substrate. However, this results in the upper surface of the filler material having scratches and chatter marks which may affect the performance of an active device formed in the substrate.

The claimed invention, on the other hand, includes at least one trench with a filler material having upper surface which is unpolished and, therefore, does not have scratches and chatter marks. Therefore, the performance of an active device formed in the substrate is not adversely affected, for example, by the surface of the trench regions.

II. THE PRIOR ART REFERENCE

A. The Zheng Reference

The Examiner alleges that Zheng anticipates the claimed invention. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Zheng.

Zheng discloses a method for forming planarized oxide shallow trench isolation. In the Zheng method, a high density plasma (HDP) oxide layer is deposited in the isolation trenches. A layer of spin-on-glass is coated over the HDP oxide layer. The spin-on-glass layer and portions of the HDP oxide layer remaining are polished away so that the substrate is planarized (Zheng at Abstract).

However, contrary to the Examiner's allegations, Zheng does not teach or suggest "at least one trench comprising seamless filler material having an upper surface which is unpolished, and co-planar with a upper surface of said substrate" as recited in claims 8, 15 and 23. As noted above, conventional substrates with shallow trench isolation (STI) regions require harsh reactive ion etching (RIE) or chemical mechanical polishing (CMP) to planarize the surface of the substrate and filler material formed in trenches (Application at page 2, lines 9-18). However, this results in the upper surface of the filler material having scratches and chatter marks which may affect the performance of an active device formed in the substrate.

The claimed invention, on the other hand, includes at least one trench with a filler material having upper surface which is unpolished and, therefore, does not have scratches and chatter marks (Application at page 12, line 16-page 13, line 1). Therefore, the performance of an active device formed in the substrate is not adversely affected, for example, by a surface of the trench regions.

Specifically, the claimed substrate may be formed using a novel method which eliminates the need for RIE and CMP in order to planarize the substrate and trench regions. As explained in the Application, the novel method may include forming a trench in a substrate, and forming a pad nitride on an upper surface of the substrate (Application at Figure 1). A non-conformal filler material (e.g., high density plasma oxide) may be used to fill a trench (Application at page 5, line 19-page 7, line 19). Importantly, the filler material

may be etched slightly to expose a portion of the pad nitride near the trench (Application at Figure 2; page 7, line 20-page 8, line 9), and a photoresist formed over the trench region to protect the filler material in the trench (Application at Figure 3; page 8, line 10-page 9, line 10). The filler material remaining on the pad nitride may then be etched away, while the filler material in the trench is not etched (Application at Figure 4). The photoresist and pad nitride may then be removed resulting in the planarized structure shown in Figure 7 (Application at page 9, line 9-page 10, line 10).

Applicant respectfully submits that this novel method of forming the claimed substrate results in the novel features of the claimed invention, including a filler material surface which is unpolished and coplanar with a substrate surface. Applicant respectfully submits that without using the novel method it would be unlikely to form a substrate having these novel features.

Clearly, Zheng does not teach or suggest these novel features. Indeed, Zheng does not use this novel method of forming the claimed substrate. For instance, Zheng teaches going immediately from the structure of Figure 5 to the structure of Figure 6 by chemical mechanical polishing. Therefore, Applicant submits that it is unlikely that Zheng may form the claimed substrate.

More particularly, Zheng specifically teaches chemical mechanical polishing in order to planarize the STI region (Zheng at col. 3, lines 22-26). The Examiner alleges that Zheng teaches that the etching may be optionally used to planarize the surface. However, Zheng states only that etch back may be used to achieve the structure shown in Figure 5 (Zheng at col. 3, lines 16-20). To then achieve the structure of Figure 6, Zheng teaches only one method and that is CMP (Zheng at col. 3, lines 21-25).

Therefore, Zheng clearly teaches a filler material having a polished surface which is contrary to the claimed invention. Moreover, Zheng does not seek to achieve a filler surface which is co-planar with the substrate surface (Zheng at Figure 7; col. 3, lines 33-41). Therefore, Zheng clearly does not teach or suggest an "unpolished and co-planar" filler material surface.

Therefore, Applicant submits that Zheng does not teach or suggest each and every

element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Liao Reference

The Examiner alleges that Liao would have been combined with Zheng to form the claimed invention. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Liao discloses an method of fabricating a shallow trench isolation. In the Liao method, a trench is formed an an isolation layer is formed to fill the trench. The isolation layer is planarized by chemical mechanical polishing with the hard mask layer as an stop layer, so that a micro-scratch is formed on a surface of the isolation within the trench. A sacrificial layer is formed on the isolation layer and the hard mask layer. The micro-scratch is thus filled with the sacrificial layer. Using the hard mask as an etch stop, the sacrificial layer is etched back. Since the etching rate of the sacrificial layer is the same as or lower than the isolation layer within the trench, the formation of the micro-scratch is suppressed during the etching back process (Liao at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different matters. Specifically, Zheng is directed to forming STI regions whereas Laio is merely directed to filling in microscratches formed by CMP (Laio at col. 1, lines 13-17). Therefore, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that "[o]ne skilled in the requisite art ... would choose the removal method taught by Zheng that will result in a substantially scratch free surface as taught by Laio" which is insufficient to support the combination.

Moreover, Laio, like Zheng, does not teach or suggest "at least one trench comprising seamless filler material having an upper surface which is unpolished, and co-planar with a

upper surface of said substrate" as recited in claims 8, 15 and 23. As noted above, conventional STI regions are formed using CMP, resulting in the filler material having scratches and chatter marks.

The claimed invention, on the other hand, includes at least one trench with a filler material having upper surface which is unpolished and, therefore, does not have scratches and chatter marks (Application at page 12, line 16-page 13, line 1). Therefore, the performance of an active device formed in the substrate is not adversely affected, for example, by a surface of the trench regions.

Specifically, the claimed substrate may be formed using a novel method which eliminates the need for RIE and CMP in order to planarize the substrate and trench regions. Applicant respectfully submits that this novel method of forming the claimed substrate results in the novel features of the claimed invention, including a filler material surface which is unpolished and coplanar with a substrate surface. Applicant respectfully submits that without using the novel method it would be unlikely to form a substrate having these novel features.

Clearly, Laio does not teach or suggest these novel features. Indeed, Laio does not use this novel method of forming the claimed substrate. For instance, Laio teaches merely forming an oxide layer in a trench and on a mask layer 24 to form an isolation layer 30. Then Laio uses CMP to planarize the isolation layer (Laio at col. 2, lines 53-60). Therefore, Applicant submits that it is unlikely that Zheng may form the claimed substrate.

In other words, like Zheng, Laio specifically teaches chemical mechanical polishing in order to planarize the surface of the isolation layer 30 (Zheng at col. 3, lines 22-26). Indeed, the whole purpose of Laio is to provide a method of filling scratches formed by CMP. Certainly, no person of ordinary skill in the art would rely upon a reference whose primary objective is to repair scratches caused by CMP to form the claimed invention which may be formed without CMP.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Brewer Reference

The Examiner alleges that Brewer would have been combined with Zheng to form the claimed invention. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Brewer discloses a planarization composition for chemical mechanical planarization of dielectric layers for semiconductor manufacture, and methods for using the planarization composition in the manufacture of semiconductor devices (Brewer at Abstract).

However, Applicant submits that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different matters. Specifically, Zheng is directed to forming STI regions, whereas Brewer is merely directed to a planarization composition for CMP (Laio at col. 1, lines 13-17). Therefore, no person of ordinary skill in the art would have considered combining these references.

Further, Applicant submits that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner supports the combination by merely stating that "[o]ne skilled in the requisite art ... would modify Zhang by adding dopant to the oxide trench fill as suggested by Brewer with reasonable expectation of producing a trench fill of a desired dielectric constant" which is insufficient to support the combination.

Moreover, Brewer, like Zheng and Laio, does not teach or suggest "at least one trench comprising seamless filler material having an upper surface which is unpolished, and co-planar with a upper surface of said substrate" as recited in claims 8, 15 and 23. As noted above, the claimed invention includes at least one trench with a filler material having upper surface which is unpolished and, therefore, does not have scratches and chatter marks (Application at page 12, line 16-page 13, line 1). Therefore, the performance of an active device formed in the substrate is not adversely affected, for example, by a surface of the trench regions. Specifically, the claimed substrate may be formed using a novel method which eliminates the need for RIE and CMP in order to planarize the substrate and trench regions.

Clearly, Brewer does not teach or suggest these novel features. Indeed, Brewer is merely directed to a composition for chemical mechanical polishing. Therefore, Brewer clearly does not teach or suggest a filler material with an unpolished surface which is co-planar with a upper surface of the substrate.

Further, Brewer may disclose a trench region in a substrate (Brewer at Figure 7b). However, the whole point of Brewer is to improve a CMP process for forming a trench region (Brewer at col. 11, line 40- col. 12, line 22). Therefore, like Laio, it is unlikely that any person of ordinary skill in the art would rely upon Brewer whose primary objective is to improve a CMP process, to form the claimed invention which may be formed without CMP.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 8, 15 and 23-35, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 09-0456.

Respectfully Submitted,

Date: 7/2/02

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 31-35 have been added.

The claims were amended as follows:

8. (Twice Amended) A semiconductor substrate comprising:

at least one trench comprising seamless [seam-less] filler material having an upper [a] surface which is unpolished [substantially scratch-free] and co-planar with a upper surface of said substrate.

15. (Twice Amended) A semiconductor substrate having a planarized trench region formed according to a method comprising:

forming a pad on a surface of said substrate;

forming at least one trench in said substrate;

applying a seamless filler material by high density plasma method in said at least one trench and on said pad;

selectively removing said filler material on said pad so as to separate said filler material in said at least on trench and said filler material on said surface by an exposed area of said pad, [and]

removing said filler material on said pad,

wherein said filler material has an upper surface which is unpolished and co-planar with a upper surface of said substrate.

23. (Thrice Amended) A semiconductor substrate having a planarized structure formed according to a method comprising:

forming a pad on a surface of said substrate;

forming at least one trench in said substrate;

applying a seamless filler material by high density plasma method in said at least one trench and on said pad, said filler material filling at least a portion of said at least one trench;

selectively removing said filler material on said pad so as to separate said filler material in said at least on trench and said filler material on said surface by an exposed area of said pad, and

removing said filler material on said pad while allowing said filler material in said at least a portion of said at least one trench to remain,

wherein said filler material has an upper surface which is unpolished and co-planar with a upper surface of said substrate.

25. (Amended) The semiconductor substrate according to claim 8, wherein said at least one trench comprises at least one [a] wide trench and at least one [a] narrow trench.

29. (Amended) The semiconductor substrate according to claim 8, wherein said surface of said filler material and said surface of said substrate are planarized [is formed] without [chemical mechanical polishing and] reactive ion etching.